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III. THE FAMILIES OF THE EUBACTERIALES

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The order Eubacteriales may be characterized as follows:

Order 1. **Eubacteriales**, ordo nov.

Synonyms:

Bacterina Perty (1852, p. 179, in part)

Eubacteria Schroeter (1882, p. 154)

Eubacteria Migula (1900, p. 1)

Eubacteriaceae A. J. Smith (1902, p. 270)

Haplobacteriacei Fischer (1895), in part

Haplobacterinae Fischer (1903), in part

This order includes the true bacteria, those forms which are least differentiated and least specialized. The cells are usually minute, spherical, rodshaped or spiral, not typically producing true filaments although the cells may occur in chains or other groups. The cells do not have a well-organized or differentiated nucleus. They may be motile by means of flagella, or non-motile, never notably flexuous. Multiplication by transverse fission, never by longitudinal. Some forms, particularly rod-shaped types, produce endospores, but never conidia. Branching of cells occurs in a few forms which intergrade with the Actinomycetales. Neither sulphur granules nor bacteriopurpurin are present, though the cells may be pigmented. Chlorophyll is absent (with the possible exception of one genus.) The cells may be united into gelatinous masses, but never form motile pseudoplasmodia, nor develop a highly specialized cyst-producing fruiting stage.

With very few exceptions, authors have recognized that the group here termed the order *Eubacteriales* should be divided into three subgroups or families on the basis of the shape of the cell, that is, into cocci, bacilli and spirilla. Cohn (1872) used the names *Sphaerobacteria*, *Microbacteria*, *Desmobacteria* and *Spirobacteria* to designate the cocci, the short rods, the long rods and the spirilla respectively. Zopf (1883) used the names *Coccaceen* and *Bacteriaceen*, later (1885) including the spiral forms with the rods under the second family. Flüge (1886) termed the three groups *Mikrobakterien*, *Bacillen* and *Spirillen*. Schroeter (1886) used *Coccacei* and *Bacteriacei* in the sense of Zopf. Trevisan (1885) and De Toni and Trevisan (1889) include all spherical organisms under *Coccogenae* and all rods and spirals under *Baculogenae*. Sternberg (1892) employed the terms *Micrococci*, *Bacilli* and *Spirilla*. Migula (1894, 1895, 1897, 1900, 1904) uses the family names *Coccaceae*, *Bacteriaceae* and *Spirillaceae*. In this nomenclature he is followed by Lehmann and Neumann (1896), Chester (1897, 1901), A. J. Smith (1902), Kendall (1902), E. F. Smith (1905), Schneider (1912), Engler (1912), and Vuillemin (1913).

Hueppe (1895) termed the families *Coccaceae*, *Bacteriaceae* and *Spirobacteriaceae*. Matzschita (1902), Fischer (1903) and Flüge (1905), use *Coccaceae*, *Bacillaceae* and *Spirillaceae*.

The principal departure from this type of classification is that of Jensen. As previously noted, this author does not recognize a group corresponding to the *Eubacteriales*. The families which he lists that would fall under this group as here defined would be *Oxidobacteriaceae*, *Luminobacteriaceae*, *Reducibacteriaceae*, *Acidobacteriaceae*, *Alkalibacteriaceae*, *Butyribacteriaceae* and *Putribacteriaceae*.

It is evident from the names which have been used that most authors have adhered very strictly to morphology as a basis for separation of families, while Jensen has emphasized physiology. It would seem that wherever a morphological basis for grouping does not lead to the separation of closely related forms, and the inclusion of unlike types in the same group, it should be employed, but when such occurs another method of separation,

probably based upon physiological characters should be used. The unanimity with which the separation into families on the basis of shape has been used would indicate that in general it has proved fairly satisfactory. In a few cases it probably leads to somewhat anomalous results. For example, to any student of the lactic acid bacteria the separation of the lactic streptococci and bacilli into different families is difficult in view of the numerous intergradations. Perhaps even more striking is the inclusion in separate families of Winogradsky's *Nitrosococcus* and *Nitrosomonas* in most classifications. The organisms belonging to the two genera are evidently closely related, they are both prototrophic, oxidize ammonia to nitrates, and do not develop on ordinary media. It would seem that these genera together with *Nitrobacter* might well be grouped together as a distinct family.

Many of the names which have been proposed for these families do not conform to the rule of the botanical code which reads "Families are designated by the name of one of their genera or ancient generic names with the ending *aceae*." With this rule in mind and with due respect to priority, the family names may be designated as *Coccaceae*, *Bacteriaceae*, *Spirillaceae* and *Nitrobacteriaceae*.

Following is a key to these families, giving the principal characteristics.

Key to the families of the Eubacteriales

- A. Organisms usually growing more or less readily upon organic media, not securing growth energy primarily by the oxidation of ammonia or nitrites.
 - I. Cells typically spherical.....Family I. *Coccaceae*
 - II. Cells not spherical, elongate.
 - a. Cells not spiral.....Family II. *Bacteriaceae*
 - b. Cells spiral, or at least curved.....Family III. *Spirillaceae*
- B. Not growing readily or at all on media containing considerable amounts of organic material; nitrifying bacteria, securing growth energy primarily by the oxidation of ammonia or nitrites.
 - Cells may be either spherical or rod-shaped,
 - Family IV. *Nitrobacteriaceae*

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